Claims

1. Device for health monitoring of an area of a structural element comprising at least one dielectric material of dielectric permittivity ε_r comprising:
(A) means of emission of electromagnetic radiation extending in a direction, the said electromagnetic field generating an electric field in the area, and
(B) detection means suitable for measuring a first measured component of an electric field, along a first direction of detection,
characterized in that the said device furthermore comprises calculation means (C) suitable for obtaining a value of the dielectric permittivity ε_r in the said area on the basis of the said first measured component.

2. Device according to Claim 1, in which the said structural element is an inhomogeneous structural element furthermore comprising an imperfectly conducting material, of electrical conductivity σ,
in which the means of emission are means of emission of magnetic radiation that are suitable for generating a magnetic field, the said magnetic field being, at the area, equivalent to a magnetic field emitted by a magnetic dipole extending in the said direction,
and in which the calculation means (C) are alternatively or furthermore suitable for obtaining a value of the electrical conductivity σ in the said area on the basis of the said first measured component.

3. Device according to Claim 2, in which the said detection means are suitable for furthermore measuring a second measured component of the said electric field, along a second direction of detection forming with the said first direction of detection a nonzero angle,
and in which, the calculation means are suitable for obtaining a value of the electrical conductivity σ and of the electrical permittivity ε_r in the said area on

the basis of the said first and the said second measured components.

4. Device according to Claim 3, in which a direction chosen from the first and the second direction of detection is the said direction of means of emission.

5. Device according to Claim 2, in which the said means of emission comprise a layer comprising, at said area, at least two parallel conducting tracks, oriented along the said dipole direction and suitable for being able to be traversed in mutually opposite senses by an electric current.

6. Device according to Claim 3, in which the said detection means comprise a layer comprising, at said area, at least one conducting track oriented along the said first direction of detection, and a layer comprising, at said area, at least one conducting track oriented along the said second direction of detection.

7. Device according to Claim 2, in which the calculation means comprise:

(Z) memory means suitable for containing a model of the area by at least two numerical parameters related to σ^s representing the said electrical conductivity σ in this area, and ε_r^s representing the said dielectric permittivity in this area, and a model of the said means of emission,

(E) estimation means suitable for estimating a simulated component of a simulated electric field generated in the said model of the area by the said model of means of emission, along the said first direction of detection, and

(F) comparison means suitable for comparing the said simulated component and the said corresponding measured component obtained by the means of detection (B).

8. Device according to Claim 3, in which the calculation means comprise:

(Z) memory means suitable for containing a model of the area by at least two numerical parameters related to σ^s representing the said electrical conductivity σ in this area, and ε_r^s representing the said dielectric permittivity in this area, and a model of the said means of emission,

(E) estimation means suitable for estimating a first and a second simulated component of the said simulated electric field along the said first and second directions of detection, and

(F) comparison means suitable for comparing the said simulated components and the said corresponding measured components obtained by the detection means (B).

9. Device according to Claim 7 furthermore comprising (D) generating means suitable for generating the said model contained in the memory means (Z).

10. Device according to Claim 2, furthermore comprising

(G) a database containing data relating to an energy absorbed by a structural element exhibiting an electrical conductivity σ and a dielectric permittivity ε_r for the said materials.

11. Device according to Claim 2, furthermore comprising a layer for integrated monitoring of the structures based on piezoelectric technology.

12. Device according to Claim 1 in which the said structural element comprises no imperfectly conducting material,

and in which the means of emission are means of emission of electrical radiation that are suitable for generating an electric field extending in the said direction.

13. Structure suitable for health monitoring of an area of a structural element of the said structure, and comprising:
the said structural element comprising at least one dielectric material of dielectric permittivity ε_r,
an electromagnetic radiation emission layer extending in a direction, the said electromagnetic field generating an electric field in the area,
a detection layer suitable for measuring a first measured component of an electric field, along a first direction of detection, and
at least one facility for connection to calculation means suitable for obtaining a value of the dielectric permittivity ε_r in the said area on the basis of the said first measured component.

14. Structure according to Claim 13 in which the said structural element is an inhomogeneous structural element furthermore comprising an imperfectly conducting material, of electrical conductivity σ,
in which the means of emission are means of emission of magnetic radiation that are suitable for generating a magnetic field, the said magnetic field being, at the area, equivalent to a magnetic field emitted by a magnetic dipole extending in the said direction,
and in which the calculation means (C) are alternatively or furthermore suitable for obtaining a value of the electrical conductivity σ in the said area on the basis of the said first measured component.

15. Structure according to Claim 13, the said structural element taking the form of at least one layer, the said detection layer being disposed between the said structural element layer and the said emission layer.

16. Structure according to Claim 13, the said structural element taking the form of at least one

layer, the said emission layer being disposed between the said structural element layer and the said detection layer.

17. Structure according to Claim 13, the said structural element taking the form of at least one layer, the said structural element layer being disposed between the said emission layer and the said detection layer.

18. Structure according to Claim 14, the said inhomogeneous structural element taking the form of at least one fine layer comprising at least one imperfectly conducting material in the form of at least one carbon fibre, of electrical conductivity σ, and one dielectric material in the form of a matrix of dielectric permittivity ε_r, in which the said carbon fibres are embedded.

19. Method for health monitoring of an area of a structural element comprising at least one dielectric material of dielectric permittivity ε_r, comprising the steps during which:

(a) an electromagnetic field is generated, by means of emission of electromagnetic radiation extending in a direction, the said electromagnetic field generating an electric field in the area, and

(b) a first measured component of an electric field is measured, along a first direction of detection,

characterized in that the method furthermore comprises a step (c) during which a value of the dielectric permittivity ε_r in the said area is obtained on the basis of the said first measured component.

20. Method according to Claim 19, in which the said structural element is an inhomogeneous structural element furthermore comprising an imperfectly conducting material, of electrical conductivity σ,

in which, during step (a), a magnetic field is generated by means of emission of magnetic radiation, the said magnetic field being, at the area, equivalent to a magnetic field emitted by a magnetic dipole extending in the said direction,
and in which during step (c), a value of the electrical conductivity σ in the said area is alternatively or furthermore obtained on the basis of the said first measured component.

21. Method according to Claim 19, in which, during a first iteration, steps (a) to (c) are performed for a first frequency of the emission means,
during a second iteration, steps (a), (b) and (c) are repeated for a second frequency, and
during step (c) of the second iteration, the value obtained during step (c) of a previous iteration is taken into account.

22. Method according to Claim 20, in which, during each step (b), a second measured component of the said electric field is furthermore measured, along a second direction of detection forming with the said first direction a nonzero angle,
and in which, during step (c) of each iteration, the said first and second measured components are taken into account.

23. Method according to Claim 20, in which, during step (c), for each iteration,
furnished, in memory means, with an initial model of the area by at least two numerical parameters related to σ^s representing the said electrical conductivity σ in this area, and ε_r^s representing the said dielectric permittivity in this area, and a model of the said emission means,
(e) at least one first simulated component of a simulated electric field generated in the said model of the area by the said model of means of emission is

estimated, along a direction of detection chosen from the said first and second direction of detection, and (f) the said simulated component and the said corresponding measured component obtained during step (b) are compared.

24. Method according to Claim 23, furthermore comprising, prior to step (e), a step (d) in which an initial model of the area by at least two numerical parameters related to σ^s representing the said electrical conductivity σ in this area, and ε_r^s representing the said dielectric permittivity in this area, and a model of the said means of emission, are generated in the memory means.

25. Method according to Claim 23, in which, during step (b), a second measured component of the said electric field is measured, along the other direction of detection,
in which, during step (e), a second corresponding simulated component of the said simulated electric field is estimated,
and in which, during step (f), the said second simulated component and the said second measured component obtained during step (b) are compared.

26. Method according to Claim 23, in which, subsequent to step (f), step (d') is furthermore implemented, in which a modified model of the area is generated by at least two numerical parameters related to σ^s representing the said electrical conductivity σ in this area, and ε_r^s representing the said dielectric permittivity in this area, differing from the initial model through at least one of the numerical parameters, and steps (e) and (f) are implemented for the said modified model.

27. Method according to Claim 23, in which step (c) furthermore comprises a step (g) during which at least

one characteristic of the area chosen from the conductivity σ and the permittivity ε_r is determined by identifying the said simulated conductivity σ^s with the said conductivity and/or the said simulated permittivity $\varepsilon^s{}_r$ with the said permittivity, as soon as the comparison performed in step (f) gives a satisfactory result.

28. Method according to Claim 20, furthermore comprising a step during which
(h) an energy absorbed by the said structural element exhibiting the said electrical conductivity σ and/or the said dielectric permittivity ε_r that are obtained in step (c) is determined by inference on a database containing data pertaining to an energy absorbed by a structural element exhibiting an electrical conductivity σ and a dielectric permittivity ε_r for the said materials.

29. Method according to Claim 20 in which the said structural element comprises no, even imperfectly, electrically conducting material, in which, during step (a), an electric field is generated in the area, in the said direction, with the aid of means of emission of electrical radiation.

30. Method according to Claim 29, in which, during step (c),
furnished, in memory means (3), with an initial model of the area by at least one numerical parameter related to $\varepsilon_r{}^s$ representing the said dielectric permittivity in this area, and a model of the said means of emission,
(d) a simulated component of a simulated electric field induced in the said model of the area by the said model of means of emission is estimated, and
(e) the said simulated component and the said corresponding measured component obtained during step (b) are compared.